

22. (Twice Amended) A computer-readable medium bearing instructions for automatically classifying a defect on the surface of an article, said instructions, when executed, being arranged to cause one or more processors to perform the steps of:

imaging the surface to form a defect image;

classifying the defect as being in one of a predetermined number of core classes of defects based on a set of rules; and

classifying the defect as being in one of an arbitrary number of variant subclasses based on the classification of the defect as being in the one core class and being in less than the predetermined number of core classes, and based on training by the user with a set of sample defect images.

REMARKS

Claims 1-30 are pending in the application. Claims 1, 10, 19 and 22 have been amended.

In the Office Action, claims 1-5 were rejected under 35 U.S.C. §103(b) as being unpatentable over U.S. Patent 6,047,083 (Mizuno) in view of the article entitled "Automatic defect classification for semiconductor manufacturing" by Paul B. Chou et al. ("Chou"). Claim 6 was rejected under 35 U.S.C. §103(a) as being unpatentable over Mizuno in view of the discussion at page 11, lines 7-30 of the present application. Claims 7-9 were rejected under 35 U.S.C. §103(a) as being unpatentable over Mizuno in view of U.S. Patent 5,172,421 (Nakamura). Claims 10-30 were rejected as claims 1-9, because they are claiming similar subject matter as claims 1-9. These rejections are respectfully traversed. Applicant respectfully requests reconsideration and allowance of the claims in view of the following arguments.

The present invention and the cited references were discussed in detail in Applicant's Amendment of August 13, 2002. For convenience, Applicant refers the Examiner to that discussion.

The present invention utilizes the best attributes of three different types of classifiers to perform defect classification more quickly and reliably than prior art methodologies. It employs a rule-based core classifier for fast initial classification of defects into a predetermined number of core classes, the core classifier being able to work during start-up and ramp-up of a production line because it does not require examples of defects. It also uses non rule-based specific adaptive classifiers, each associated with only a small number of the core classes (e.g., with only one or two core classes), trained by the user with sample defect images, in parallel with the core classifier for subclassification within a core class. The present invention further employs a full classifier (also based on sample defect images), but only on a limited basis for special types of defects that do not fit in to the core classification scheme. Thus, as the fabrication process matures and the types of defects of interest become more diverse, the specific adaptive and full classifiers can be trained as needed to perform more detailed defect classification.

None of the cited prior art references, alone or in combination, teaches or suggests an apparatus or a method that employs both a rule-based core classifier and a non ruled-based specific adaptive classifier, as required by the claimed invention. Independent claims 1, 10, 19 and 22 have been amended for clarity to specify that the core classifier is a rule-based classifier, the specific adaptive classifier is a non rule-based classifier, and the specific adaptive classifier is associated with less than the predetermined number of core classes. These amendments are supported, for example, at page 4, lines 1-7 and page 11, lines 7-15 of the application, and in original claim 6.

Regarding the obviousness rejection of independent claims 1, 10, 19 and 22 based on Mizuno and Chou, the primary Mizuno reference teaches the use of a rule-based core classifier to classify defects into one of a predetermined number of core classes. However, as admitted in the Office Action, Mizuno fails to teach or suggest using a non rule-based specific adaptive classifier associated with the one core class and less than the predetermined number of core classes, and trained by the user with a set of sample defect images, to further classify the defect into a subclass, as required by independent claims 1, 10, 19 and 22. Rather, Mizuno teaches using a core classifier for this function. In other words, Mizuno uses a rule-based classifier to initially classify defects, and also to subclassify the defects.

It is contended in the Office Action that since Chou teaches the use of a non rule-based classifier trained by the user with sample defect images, it would have been obvious to combine the teachings of Chou and Mizuno to yield the claimed invention.

Applicant disagrees. Chou does not teach or suggest using non rule-based classifiers *associated with less than a predetermined number of core classes* to sub-classify defects, as claimed. Chou does not mention subclassification. Mizuno does not teach or suggest that its rule-based subclassifier is associated with less than a predetermined number of core classes either. The specific adaptive classifier recited in the amended independent claims is an important feature of the invention because, unlike conventional full classifiers (either the rule-based classifier of Mizuno or the non rule-based classifier of Chou) that must classify every defect as being in one of many classes (e.g., 10 classes), the inventive specific adaptive classifier analyzes only defects of the core class or classes with which it is associated (e.g., 1, 2 or 3 classes). Thus, the claimed specific adaptive classifier associated with less than a predetermined number of core classes is presented with a "sub-problem" (e.g., a defect that it knows is in one

of, say, 2 or 3 classes) that is easier to solve than the total problem (a defect that could be in one of 10 or more classes). This limit on the domain of the specific adaptive classifier enables it to classify defects more reliably and faster than a conventional classic classifier, since the specific adaptive classifier needs to consider less predicates to reach its decision in most situations.

Since neither Mizuno nor Chou teaches or suggests the claimed non rule-based specific adaptive classifier associated with less than a predetermined number of core classes, any combination of these references, however made, would still be missing this important claimed feature. Moreover, it would not have been obvious to modify any Mizuno/Chou combination to yield the invention of amended claims 1, 10, 19 or 22.

Furthermore, one skilled in the art would not have been motivated to combine Mizuno and Chou as suggested by the Examiner to yield the claimed non rule-based specific adaptive classifier, because Chou teaches away from such non rule-based classifiers. At the passage of Chou cited by the Examiner (page 208, col. 2, lines 8-20), Chou states that such non rule-based classifiers are disadvantageous because they require a large number of training samples, because adding and deleting defect classes is not facilitated, and because they do not generate explanations to aide the user's understanding of how they work.

Chou goes on to tout the advantages of a different approach to defect classification, wherein a rule-based classifier derives its rules using training samples (see page 208, col. 2, lines 21-29). Thus, if one skilled in the art were to modify Mizuno's technique in view of Chou, they would not be motivated by Chou to use a non rule-based classifier for subclassification, as claimed. Rather, the skilled artisan would most likely be motivated to adopt Chou's approach of employing a rule-based classifier whose rules can be influenced by training samples.

Thus, it would not have been obvious to combine Mizuno and Chou to yield the inventions of independent claims 1, 10, 19, and 22, because no combination of these references teaches or suggests the step of classifying a defect as being in one of an arbitrary number of variant subclasses using a non rule-based specific adaptive classifier associated with less than a predetermined number of core classes, as required by independent claims 1 and 22; and does not disclose or suggest a non rule-based specific adaptive classifier associated with less than a predetermined number of core classes for classifying the defect as being in one of an arbitrary number of variant subclasses, as required by independent claims 10 and 19.

Consequently, claims 1, 10, 19 and 22 are patentable, as are claims 2-5, 11-14, 23-26, and 30, which depend from claims 1, 10, 19 and 22, respectively.

Regarding the obviousness rejection of claims 6, and 15 based on Mizuno and page 11, lines 7-30 of the application, it is contended in the Office Action that the Applicant admits (at page 11, lines 7-30) that a plurality of specific adaptive classifiers as claimed in claims 6 and 15, each associated with less than a predetermined number of core classes, is in the prior art. This is not correct. There is no support at page 11 or anywhere else in the specification for the contention that Applicant considers the claimed plurality of specific adaptive classifiers to be in the prior art. In fact, the application is replete with statements as to the inventiveness of the claimed specific adaptive classifiers. See, for example, page 7, lines 28 et seq., distinguishing specific adaptive classifiers from prior art classic classifiers.

Since all the limitations of claims 6 and 15 are not found in the cited references, the rejection under § 103 should be withdrawn. Consequently, claims 6 and 15 are patentable.

Regarding the obviousness rejection of claims 7-9, 16-18, 20-21 and 27-29 based on the Mizuno and Nakamura references, Nakamura does not teach or suggest the recited specific

adaptive classifier of independent claims 1, 10, 19 and 22 (from which claims 7-9, 16-18, 20-21 and 27-29 depend) missing from Mizuno. Nakamura teaches a rule-based classifier (see Nakamura, Abstract). Moreover, Nakamura does not teach a classifier associated with a particular core class, as claimed. Still further, Nakamura does not teach the claimed combination of a core classifier and a specific adaptive classifier associated with a particular core class. Therefore, any combination of Mizuno and Nakamura, however made, would still be missing the claimed specific adaptive classifier, and it would not have been obvious to add the claimed specific adaptive classifier to any Mizuno/Nakamura combination.

Consequently, claims 7-9, 16-18, 20-21 and 27-29 are patentable.

Reconsideration and withdrawal of the rejection of claims 1-30 under 35 U.S.C. §103 are respectfully requested.

Accordingly, it is believed that all pending claims are now in condition for allowance. Applicant therefore respectfully requests an early and favorable reconsideration and allowance of this application. If there are any outstanding issues which might be resolved by an interview or an Examiner's amendment, the Examiner is invited to call Applicant's representative at the telephone number shown below.

To the extent necessary, if any, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted

McDERMOTT, WILL & EMERY

A handwritten signature in cursive script, appearing to read "Michael A. Messina".

Michael A. Messina

Registration No. 33,424

600 13th Street, N.W.
Washington, D.C. 20005-3096
(202) 756-8000 MAM/mcm
Date: January 13, 2003
Facsimile: (202) 756-8087